

Planning for the Community & Rapid Transit

ALRT: A NOISE STUDY

- A Discussion Paper



April,
1983

Planning Department
City of Vancouver
Director: Ray Spaxman



SUMMARY

ALRT: A NOISE STUDY

This report examines the future noise levels to be generated by ALRT when it begins operations in Vancouver in 1986. The report also describes ALRT's potential noise impacts in the residential areas adjacent to the alignment. The report uses data obtained from Harford, Kennedy, Wakefield, Acoustical Consultants, who were retained by B.C. Transit to provide a detailed analysis of future ALRT noise levels.

Although ALRT is somewhat quieter than other light rail transit systems in North America, the trains still generate noise impacts. Annoyance at rail traffic noise results not only from the once only event of the train passing but also from the number of times the noise occurs. Scientists have developed a measure of this "24 hour effect" of noise called decibels (Leq). Annoyance with noise has been found to increase sharply when noise levels exceed 55 dB (Leq), so Canada Mortgage and Housing Corporation (CMHC) has adopted 55 dB (Leq) as the maximum acceptable outdoor noise level for residential projects with Federal funding.

Twenty-four hour equivalent noise levels for ALRT at normal cruising speed result in maximum noise levels in excess of 55 dB (Leq) for all unobstructed yards and patios within 110' from the guideway between Waterfront Station and Nanaimo Street under 1986 operating conditions and all unobstructed areas within 180' if the system is expanded to its potential capacity. Between Nanaimo Street and New Westminster the distances will be 70' and 125' respectively.

Train speed, existing noise levels and the presence of barriers could influence the potential noise impact of ALRT on the adjacent residential neighbourhoods. Houses located along heavy traffic arterials already experience high noise levels, so ALRT noise will not have substantial impacts here.

However, in quiet residential areas where the ambient noise levels are low, such as in the vicinity of the east lane of Commercial Drive and adjacent to the B.C. Hydro right-of-way ALRT will be more intrusive since it will be the primary source of noise in these neighbourhoods. These areas will be the subject of further study by the City of Vancouver.

Noise impacts can be dealt with where ALRT is at grade or in cut through the erection of barriers such as fences or berms (trees and shrubs have been found to provide very little shielding from noise). Minimizing noise impacts when the ALRT guideway is elevated creates a difficult challenge as the use of traditional noise barriers is usually not possible.

In some cases, buildings themselves can act as barriers to keep the noise from the rest of the residential area. This is only feasible as a re-development option and requires careful design. A detailed assessment of the noise impacts along the alignment and methods to alleviate those impacts will be undertaken as part of the Station Area Planning Program.

ALRT: A NOISE STUDY

INTRODUCTION

No studies have been undertaken to examine the noise impacts resulting from ALRT's operations on residential areas adjacent to the guideway. This report examines the noise levels of ALRT and indicates areas where noise levels could be excessive for residential uses not properly buffered. Subsequent reports will deal with noise problems in specific areas and measures to minimize those impacts.

A first draft of this report was prepared in July, 1982. Data for predicting noise levels was based on various specification documents published by the Urban Transportation Development Corporation or British Columbia Transit (BCT). The report was circulated to B.C. Transit who retained Harford, Kennedy, Wakefield, Ltd., Acoustical Consultants, to examine the conclusions of our draft and to provide a detailed analysis of future ALRT noise levels.¹ This report incorporates the conclusions of that report and the latest information on the alignment plans for all sections.

ALRT AND NOISE

Although ALRT is somewhat quieter than most other light rail transit systems in North America, the trains still generate noise impacts. According to the System Description provided by Metro Canada Ltd., a train of four vehicles with all subsystems operating normally will generate a maximum sound pressure of 74 decibels [dB (A)] at 15 metres (50'). When compared to other noise levels ALRT is somewhere between highway traffic and Conventional LRT Systems (Table 1).

MEASURING NOISE LEVELS

While this provides some indication of ALRT's noise levels, it doesn't tell the whole story. One noise from a heavy truck in a twenty-four hour period would not be as annoying as a truck passing your house every fifteen minutes. Annoyance at road and rail traffic noise results not only from the once only event of the train passing (which is what the 74 dB (A) is a measurement of) but also the number of times the noise occurs.

Scientists have developed a measure of noise over a twenty-four hour period called the 24 hour equivalent sound level [decibels (Leq)]. Thus the fluctuating nature of ALRT noise can be translated into an equivalent steady sound in decibels.

Scientists have also correlated annoyance levels with 24 hour equivalent sound levels using surveys combined with noise measurements. Annoyance with noise has been found to increase sharply when Leq outside dwellings exceeds about 55 dB (Leq) (Figure 2). An outdoor noise level of 55 dB (Leq) would permit conversation most of the time at close range in a slightly

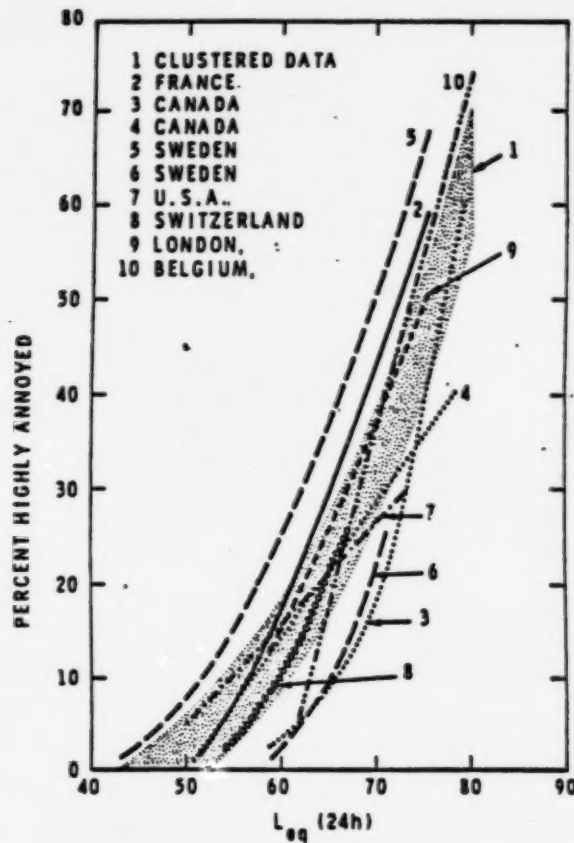
TABLE 1

COMMON NOISE LEVELS AND TYPICAL REACTIONS

Jet takeoff at 2,000'	100	Eight times as loud	
Freight train at 50'	95		
Heavy truck at 50'	90	Four times as loud	Very annoying Hearing damage (8 hours)
Conventional LRT	80	Twice as loud	Annoying
ALRT at 50'	74		
Highway traffic at 50'	70	Base reference	Telephone use difficult
Light car traffic at 50'	60	Half as loud	Intrusive
Noisy office	50	Quarter as loud	Speech interference
Public Library	40	Eighth as loud	Quiet
Soft whisper at 15'	30	Sixteenth as loud	Very quiet
	10	Sixty-fourth as loud	Just audible
Threshold of hearing	0		

NOTE: A 10 dB increase in level appears to double the loudness while a 10 dB decrease halves the apparent loudness.

Figure 2



— Annoyance versus street traffic noise; a compilation of social survey data

Table 2

C.M.H.C.

Maximum acceptable levels of road and rail traffic noise in dwelling and in outdoor recreation areas

	Noise Level
Bedrooms	35 dB
Living, dining, recreation rooms	40 dB
Kitchens, bathrooms, hallways, utility rooms	45 dB
Outdoor recreation area	55 dB

raised voice. For these reasons Canada Mortgage and Housing Corporation (CMHC) adopted 55 dB (Leq) as the maximum acceptable outdoor noise level for residential projects with Federal funding.

Maximum interior noise levels for dwellings have been developed using a similar logic² and are more stringent for bedrooms and living rooms than for kitchens and hallways (Table 2). If the maximum acceptable noise level for outdoor spaces [55dB (Leq)] is not exceeded then all interior noise criteria will automatically be satisfied as well. Noise criteria based on the Vancouver Noise By-law levels were not used because the By-law was designed to be used in enforcement, not for land use planning.

ALRT 24 HOUR NOISE LEVELS (Leq)

In December 1981, calibrated tape recordings of ALRT passbys were made on behalf of BC Transit at the ALRT Development Centre in Kingston, Ontario. The elevated test tract includes the 0.7m noise barrier to be incorporated in the Vancouver system. These recordings were subsequently analysed by Harford, Kennedy, Wakefield Ltd. to determine the Leq at 15m from the centreline of the double track guideway for a vehicle speed of 70 km/hour.

The largest factor contributing to ALRT noise levels is the frequency of trains. According to specifications provided by Metro Canada Ltd., ALRT trains in 1986 will run from 6:00 a.m. until 2:00 a.m.. Table 3 shows the proposed ALRT operating schedule with train frequencies for different time periods. During "peak" and "base" service (from 6:00 a.m. until 7:00 p.m.) the frequency will be one train every 53 seconds between Nanaimo Street and Waterfront Station and one train every 70 seconds between Nanaimo Street and New Westminster in both directions. The resulting number of trains in a 24 hour period would be 1,160 or 4,460 cars for the Nanaimo Street-Waterfront section and 829 trains or 3,316 cars for the Nanaimo Street-New Westminster section of the alignment assuming four car trains as outlined in the specifications.

While these frequencies reflect 1986 operating conditions, the system has the potential to be expanded to 75 second headways from 106 second headways.³ Using a similar operating schedule to the one in Table 3 the number of trains per day could be 1,639 or 9,834 cars for the Nanaimo Street-Waterfront section and 1,152 trains or 6,912 cars for the Nanaimo Street-New Westminster section of the alignment.

² For a detailed explanation on how these maximum levels were determined see CMHC Road and Rail Noise: Effects on Housing and National Research Council of Canada Residential Planning with Respect to Road and Rail Noise, 1979.

³ This operating capacity is outlined in the Vancouver ALRT System Description by Metro Canada Ltd.. The maximum capacity of the system is reached by adding additional cars to the system but without additional civil works such as lengthening stations.

TABLE 3

ALRT OPERATING SCHEDULE & TRAIN FREQUENCIES

		<u>Frequency of Trains*</u>	
		<u>Waterfront-Nanaimo**</u>	<u>Nanaimo-Boundary Road**</u>
<u>Monday-Friday (inclusive)</u>			
06:00 - 06:30	system startup	34/hour	26/hour
06:30 - 08:30	a.m. 'peak'		
08:30 - 16:00	'base' period: 50% of peak demand		
16:00 - 18:00	p.m. 'peak'		
18:00 - 19:00	fleet reduction		
19:00 - 23:00	'evening' service: 30% of peak demand	24/hour***	22/hour***
23:00 - 23:30	fleet reduction		
23:30 - 01:30	'owl' service: 15% of peak demand	12/hour***	11/hour***
01:30 - 02:00	shutdown		
<u>Saturday</u>			
06:00 - 06:30	startup		
06:30 - 01:30	'base' service	34/hour	26/hour
01:30 - 02:00	shutdown		
<u>Sunday</u>			
06:00 - 06:30	startup		
06:30 - 09:00	'owl' service	12/hour***	11/hour***
09:00 - 09:30	fleet buildup		
09:30 - 23:00	'base' service	34/hour	26/hour
23:00 - 23:30	fleet reduction		
23:30 - 02:30	'owl' service	12/hour***	11/hour***
01:30 - 02:00	shutdown		

* To determine the total number of trains per hour, both directions must be taken into account. Therefore, multiply each frequency by 2. (e.g. 34 trains/hour in one direction: 68 in both directions)

** One in every four trains during 'peak' and 'base' service will be turned back to the downtown from Broadway Station resulting in fewer trains from Broadway to New Westminster. Fewer trains will be turned back during 'evening' and 'owl' service. The trains will be turned back at the storage track near Gladstone Street west of Nanaimo Street.

*** Higher train frequencies may occur during 'evening' and 'owl' service when large events are being held at the Stadium.

Using the above frequencies as outlined in the specifications document and the calibrated tape recordings of ALRT passbys from the Kingston test track, Harford, Kennedy, Wakefield, Ltd., Acoustical Consultants, calculated the 24 hour equivalent noise levels for ALRT at the normal cruising speed of 70 km/hour. These noise levels are shown in Table 4 and have been calculated for both 1986 operating conditions and for potential operating capacity. The new test track soon to be opened on Terminal Avenue provides a further opportunity to refine this information.

As Table 4 illustrates, maximum acceptable noise levels for outdoor recreation areas [55dB (Leq)] west of Nanaimo Street could be exceeded for all unobstructed yards and patios within 110' from the guideway under 1986 operating conditions and all unobstructed yards and patios within 180' if the system is expanded to its potential operating capacity. Between Nanaimo Street and New Westminster the distances would be 70' and 125' respectively.

There are a number of factors which may influence noise levels along the right-of-way. These factors are the speed of the train, the presence of barriers and the existing noise levels (ambient noise) in the areas adjacent to the alignment. Each factor's influence on noise levels is discussed in detail below.

1. Train Speed

The values in Table 4 assume that ALRT vehicles will be travelling at their average cruise speed of 70 km/hour. While this is true through most of the alignment, trains will be accelerating and decelerating as they approach or leave a station. As train speeds decrease from the 70 km/hour, Leq values also decrease so that areas closer to the stations will not have as high noise levels.

2. Present Noise Levels (Ambient Noise)

One of the most important factors which will influence the noise impacts of ALRT is the current level of noise in the existing community. Houses located along heavy traffic arterials or adjacent to operating railways already experience high noise levels (Grandview Highway, 12th Avenue, Victoria Diversion, Nanaimo, Rupert, Joyce, and Boundary) and future noise impacts due to the ALRT are unlikely at these locations.

However, in quiet residential areas ALRT will be more intrusive as it will be the primary source of noise in these neighbourhoods. Therefore, it is in these areas that the greatest noise impacts will occur and further study will be required.

The east lane of Commercial Drive and the residences adjacent to the BC Hydro right-of-way have been tentatively identified as potential impact areas in Vancouver.

TABLE 4

ALRT NOISE TABLE (dB Leq)

(Speed 62-72 km/hr.)

Distance from ALRT	<u>1986 Operation</u> 4 car trains		<u>Potential Expansion</u> 6 car trains	
	<u>Nanaimo-Waterfront</u> 106 second headways* 4640 cars/day	<u>Nanaimo-New West.</u> 140 second headways* 3316 cars/day	<u>Nanaimo-Waterfront</u> 75 second headways* 9834 cars/day	<u>Nanaimo-New West.</u> 106 second headw.* 6912 cars/day
less than 35'	61	59	64	62
36' - 45'	60	58	63	61
46' - 55'	59	57	62	60
56' - 70'	58	56	61	59
71' - 90'	57	55	60	58
91' - 110'	56	54	59	57
111' - 140'	55	53	58	56
141' - 180'	53	51	56	54
181' - 225'	51	49	54	52

* These headways are for "peak" and "base" service. Headways are different for "evening" and "owl" service.

3. Presence of Barriers

The noise from ALRT may be reduced by the presence of any obstruction that interrupts the line of sight between the noise source and the receiving point. (However, trees and shrubs have been found to provide very little shielding.) The barrier might be a road embankment or cut (as between Penticton and Rupert on the BC Hydro right-of-way), an earth berm, buildings, etc..

These barriers can significantly reduce noise impacts where the guideway is at grade or in cut as between Nanaimo Street and Rupert. Barriers must be continuous and have an impervious surface weighing 9.7 kg/square metre (2 lbs/square foot).

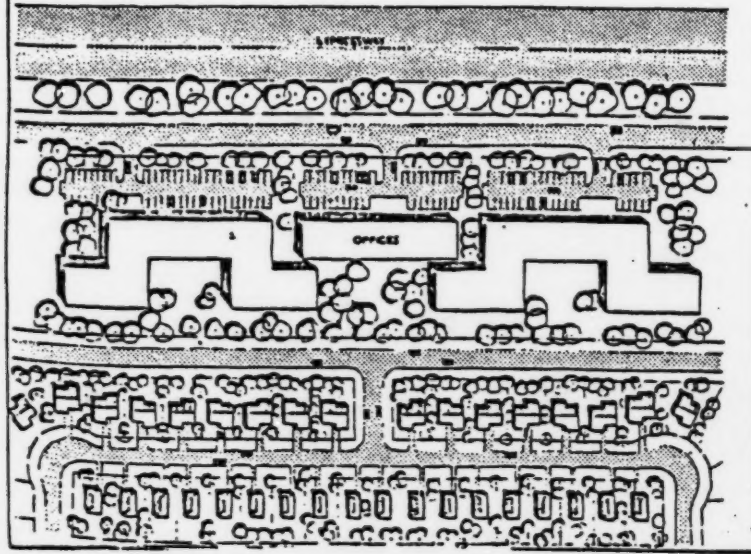
Minimizing noise impacts when the ALRT guideway is elevated creates a difficult challenge. Traditional 1.8m (6') high backyard fences are not high enough to reflect the noise from over 20' high guideways. Physical separation is an obvious answer when there is enough space available but in many sections of Vancouver the proximity of existing buildings and the high cost of land makes separation impossible.

In some cases buildings themselves can act as barriers to keep the noise from the rest of the residential area. This is only feasible as a redevelopment option and requires careful design. Intervening structures are more effective when houses are linked, (as in town-housing or multiple units), creating a continuous barrier (see Figure 5).

A detailed assessment of the noise impacts along the alignment will be carried out as part of the general assessment of ALRT impacts along the right-of-way as a method to alleviate these impacts.

Figure 5

Office buildings separate noise source and residential area.



Buildings act as a barrier to noise, resulting in acceptable noise levels in the recreational area and beyond. The building must be architecturally designed internally to deal with the indoor noise problem

CONCLUSION

This report illustrates that while ALRT is quieter than other light rail transit systems in North America, the noise levels are high enough to create noise impacts in adjacent residential areas. Much of this impact will only become apparent when ALRT ridership reaches the ultimate capacity of the system and train frequencies increase. It is also clear that specific noise attenuation measures are needed in quiet residential areas adjacent to the guideway to minimize these noise impacts. A detailed assessment of the noise impacts along the alignment and methods to alleviate those impacts will be undertaken as a part of the Station Area Planning Program.